



## Early Results of Surgical Treatment of Volar Barton Fractures by Plating in Adults

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Submit Date 15-02-2024

Revise Date 27-02-2024

Accept Date 28-02-2024



### ABSTRACT

**Background:** A Barton fracture is a distal radius articular fracture that causes the radiocarpal joint to volarly dislocate. However, the radio-carpal ligaments are not disrupted; rather, the distal radius suffers a compression injury with an intraarticular marginal shearing tension. **Aim:** to assess and make improvements to the clinical and radiological results of adult volar Barton fracture fixation with a plate. **Patients and Methods:** This is a prospective interventional study that was conducted for the care of distal radius volar Barton fractures with plating at Zagazig University Hospitals. The mean follow-up period was six months. **Results:** The study revealed that the average duration of bone union was  $8.33 \pm 1.37$  weeks. From preoperative to postoperative periods, flexion's clinical and functional results improved; this difference was statistically significant. Preoperative radial deviation was  $5.83 \pm 3.99$ . Postoperative radial deviation improved to  $13.75 \pm 3.8$ , with a statistically significant change. Following surgery, the average DASH score for the study's patient cohort was  $14.89 \pm 8.21$ . Seven patients (58.3%) reported very high levels of satisfaction. Three patients (or 25%) reported being very satisfied. 16.6% of the patients had superficial infections. 8.3% of patients had a malunited fracture, and 8.3% of patients exhibited stiffness. **Conclusion:** An efficient treatment for enhancing functional and radiological results is plating of the volar Barton fracture. Using locking compression plates can help achieve fracture stability and early postoperative mobilization. It offers quick movement and active recuperation. Precise anatomic reduction of the fracture and restoration of the wrist's morphology and function are made possible by quick and low-complication surgery.

**Keywords:** Volar Barton Fractures, Plating, outcomes, complication

## INTRODUCTION

A distal radius fracture known as a Barton fracture causes the radiocarpal joint to dislocate when it breaks through the articular surface. The distal radius articular surface is still in touch with the proximal carpal row, which separates the Barton fracture from other forms of distal radius fractures or dislocations. There are two types of Barton fractures [1-3].

Fractures caused by volar Barton are not unusual. These fractures have a bimodal distribution; in young individuals, they are typically observed as high energy trauma, whereas in older adults, they are seen as osteoporotic fractures and low energy traumas [4,5].

A Barton fracture brought on by the distal radius's marginal shearing force and compression force. A triangular section of the distal radius and the carpus are in volar displacement because of the compression force that flows from the hand and wrist to the articular surface of the radius. The scaphoid and lunate fossa of the distal radius, the radiocarpal ligaments, the joint capsule, and other tissues all work together to sustain the attachment between the radius and the carpal bones [6-9].

A more rapid return to function and radiographic results for ligaments, the joint capsule, and the scaphoid and lunate fossa of the distal radius have all been obtained using volar buttress plating surgery [10-13].

The objective of the current study was to assess the clinical and radiological results of adult volar Barton fracture repair by plate and to determine ways to enhance them.

### PATIENTS AND METHODS

This study is a prospective interventional study included 12 patients at Orthopedic Department, Zagazig University Hospitals for distal radius volar Barton fracture management with plating from June 2022 to September 2023 with mean follow up 2 years.

#### Inclusion criteria:

Patient after skeletal maturity, closed distal radius volar Barton fractures.

#### Exclusion criteria

Patient before skeletal maturity associated ipsilateral upper limb fractures, patient unfit for surgery.

#### Preoperative assessment

The pre-operative evaluation included a clinical examination and a history taking. Information on name, age, sex, and kind of injury are collected. Radiographic assessment consists of preoperative AP and lateral view radiographs as well as, in a few carefully selected cases, CT evaluation. ECG in addition to CBC, liver, kidney, and coagulation profile lab tests.

#### Ethical considerations:

Written informed consent was obtained from all participants, the study was approved by the research ethical committee of Faculty of Medicine, Zagazig University (IRB #3876-2021). The study was done according to The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

#### Operative technique

Under general anaesthesia, patients had procedures on a typical radiolucent operating table. During surgery, a tourniquet is used to create a bloodless environment. The plane between the radial artery and the flexor carpi radialis tendon was used in the modified Henry method. The fracture site became visible following the pronator quadratus muscle's relaxation. reduction of the fracture while being seen directly. Under the assistance of an image intensifier, the plate was positioned on the anterior aspect of the radius and secured with a variable angle locking screw. Layer-by-layer closure of the wound (**Figure 1**).

#### Postoperative and follow up (follow up period 6 months)

Clinical and radiological examinations were performed on all patients right after surgery. The patient received intravenous antibiotics for the next 72 hours, then oral antibiotics for 5 days. The patient was discharged in 2–3 days, and there were follow-up appointments at 2 weeks, 6 weeks, 3 months, and 6 months after surgery. Radiological examinations using AP and lateral views were also

performed, and any complications from the procedure were recorded during the follow-up period (**Figure 2**).

**STATISTICAL ANALYSIS**

All data were collected, tabulated and statistically analyzed using IBM Corp. Released 2015. IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp. Quantitative data were expressed as the mean±SD & median (range), and qualitative data were expressed as number & (percentage). t test was used to compare two groups of normally distributed variables. Mann whitney u test, Chi-square test or Fisher exact test, and logistic regression were used. Hosmer and Lemeshow test were used to detect goodness of fitness of logistic regression model. All tests were two sided. P-value < 0.05 was considered statistically significant, p-value ≥ 0.05 was considered statistically insignificant.

**RESULTS**

The mean age of patients in the study was 40.33±11.7years (range 21–59) years, the gender was 8 males (66,7%), 4 females (33,2%), the occupation was 7 heavy workers (58.33%), 3 light workers (25%), 2 housewives (16.7%) (**Table 1**).

After surgery, the mean ± SD of flexion increased from (29.58±8.76) (range 15–40°) to (66.25±7.93) ranged 50–75°, with a statistically significant difference (p<0.0001). The statistically significant difference, p<0.0001, was observed in the mean ± SD of extension from (12.5±4.78) ranged 5–20° preoperatively to (55.83±6.71) ranged 45–65°postoperatively. After surgery, the mean ± SD of radial deviation decreased from

(5.83±3.99) ranged 0–10 to (13.75±3.8) ranged 7–20, with a statistically significant difference (p<0.0001). The difference between the mean ± SD of ulnar deviation preoperatively (7.5±4.7) ranged 0–15 and postoperatively (32.08±6.9) ranged 20–40 was statistically extremely significant (p<0.0001). (**Table 2**).

Preoperatively, the mean ± SD of radial length was 6.8±1.4 (range 5–9); postoperatively, it increased to 9.91±1.38) ranged 8–12, with a statistically significant difference (p<0.0001). Before surgery, the mean ± SD of radial inclination was 18.41±3.2 (range 13–25), but after surgery, it climbed to 21.66±2.32 ranged 18–25, with a statistically significant difference (p=0.0001). Before surgery, the mean ± SD of volar tilt was 8.6±1.1 ranged 7–11, but after surgery, it climbed to 9.9±0.99 ranged 8–11, with a statistically significant difference (p<0.0001). The range of preoperative articular step off was 5 to 12, with a median of 8, and it dropped postoperatively to a range of 0 to 2, with a median of 1, and the percent improvement was 86.18%. The mean DASH score of patients in the study was 14.89±8.21 (range 5–35.7) (**Table 3**).

Patients’ satisfaction: 7 patients had excellent satisfaction level (58.3%), 3 patients had good satisfaction level (25%), 1 patient had fair satisfaction level (8.3%) with DASH score between, 1 patient had poor satisfaction level (8.3%) (**Table 4**).

Regarding complication, 2 patients had superficial infection (16.6%), 1 patient had malunited fracture (8.3%), 1 patient had stiffness (8.3%) (**Table 5**).

**Table 1: Demographic characters of studied group**

Variables		
Age per years		
Mean ± SD	40.33±11.7	
Range	21-59	
	n.	%
Gender	8	66.7
Males	3	33.3
Females		

Variables		
Occupation		
Heavy workers	7	58.33
Light workers	3	25
House wife	2	16.7

**Table 2: Comparison of range of motion pre- and post-operative for studied patients**

Variables	Time		P
	Pre-operative	Post-operative	
<b>Flexion</b>			
Mean ± SD	29.5 ±9.59	60.67±6.53	<0.001**
Range	(10-40)	(50-75)	
<b>Extension</b>			
Mean ± SD	12.47 ± 5.55	57.63 ±5.28	<0.001 **
Range	(0-20)	(45-65)	
<b>Radial deviation</b>			
Mean ± SD	6.57±3.04	10.67±2.48	<0.001 **
Range	(0 -10)	(8-17)	
<b>Ulnar deviation</b>			
Mean ± SD	12.37 ± 2.95	28.7±6.3	<0.001 **
Range	(0 – 15)	(18-44)	

**Table 3: Comparison of radiological data and DASH score for studied patients**

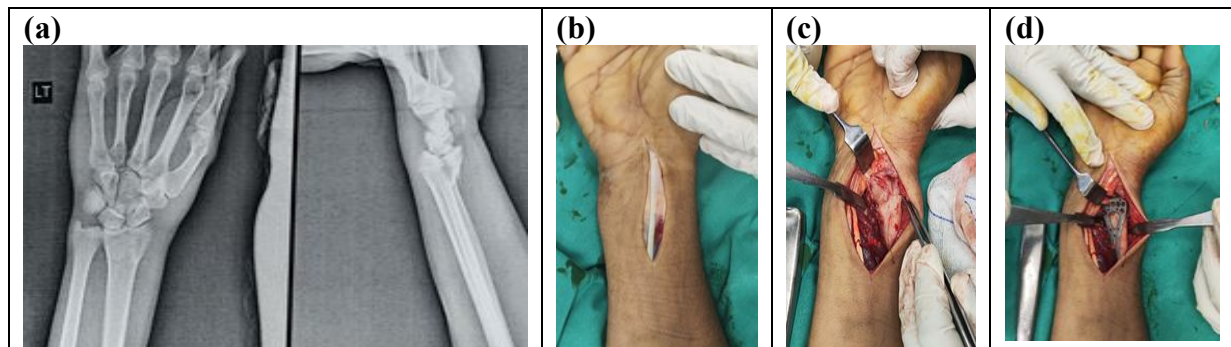
Radiological Variables	Time		p
	Pre	Post	
<b>Radial length</b>			
Mean ± SD	9.3±1.2	10.2±1.2	<0.001**
Range	(7-11)	(8-12)	
<b>Radial inclination</b>			
Mean ± SD	18.9±1.2	20.9±1.49	<0.001**
Range	(17-21)	(18-23)	
<b>Volar tilt</b>			
Mean ± SD	8.6±1.1	9.9±0.99	<0.001**
Range	(7-11)	(8-11)	
<b>Articular step off</b>			
Median	8	1	<0.001**
Range	(5 – 12)	(0 – 2)	
<b>Variable</b>	<b>Post-operative DASH score</b>		
<b>DASH score</b>			
Mean ± SD	14.89±8.21		
(range)	(5-35.7)		

**Table 4: Patients' satisfaction of the studied group**

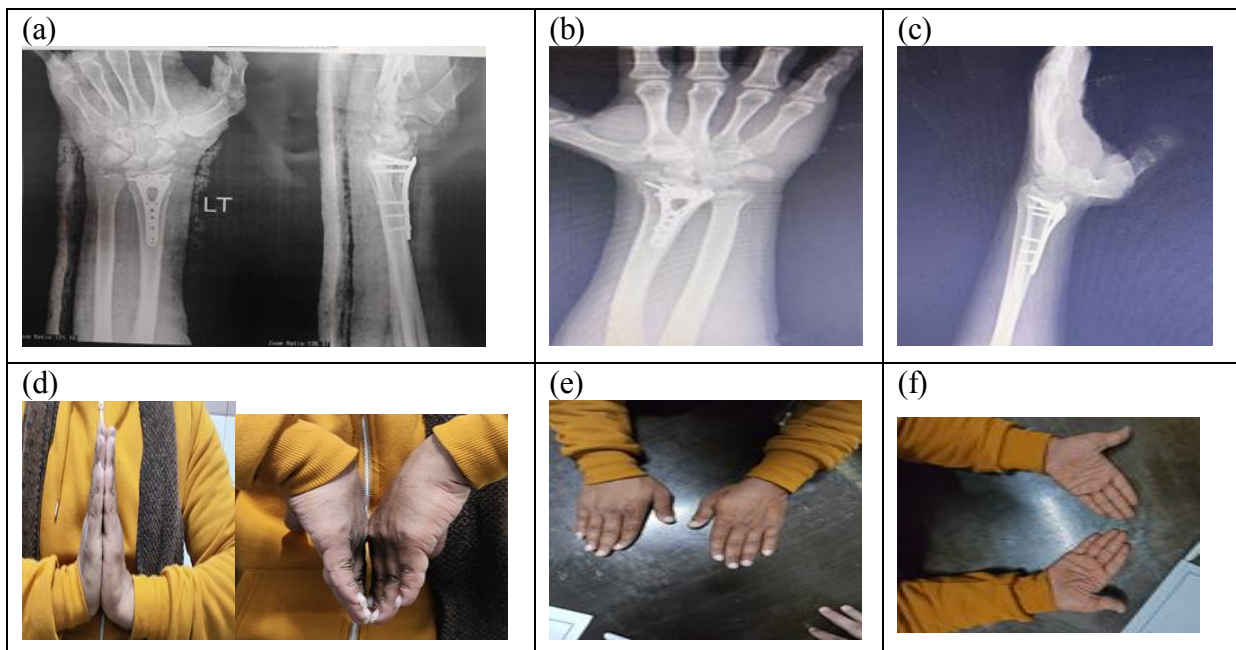
	n.	%
<b>Satisfaction level</b>		
Excellent	7	58.3
Good	3	25
Fair	1	8.3
Poor	1	8.3

**Table 5: Complications among the studied patients**

Complications		N. (%)
<b>Intraoperative complications</b>		0
<b>Postoperative complications</b>		
<b>Early</b>	Superficial infections	2(16.7%)
<b>Late</b>	Mal union	1(8.3%)
	Stiffness	1(8.3%)



**Figure (1): Operative technique (a) shows AP and lat. plan x ray for Volar Barton fractures; (b)modified Henry approach, (c) exposure of fracture, (d) reduction by plate and screws under fluoroscopy.**



**Figure (2): showing (a) Post-operative x-ray; (b, c): follow up: 6 month Post-operative x-ray; (d-f) Rom 6 month post-operatively.**

## DISCUSSION

Intra-articular fractures known as Barton fractures are caused by shear pressures that cause the volar or dorsal lips of the distal radius to shift. The volar subluxation of the radiocarpal joint is nearly usually linked to volar Barton, which is more prevalent. Conservative treatment of volar Barton fractures is linked to a variety of comorbidities and an unsatisfactory result. Early wrist movements are essential for a successful outcome, but this is only achievable if a near-anatomical reduction is achieved and then a strong fixation is made. Using a volar locking plate for ORIF is one of the many management strategies described in the literature. The objective of this study was to evaluate the functional results of adult patients treated with ORIF and volar locking plate for volar Barton fractures [14].

The primary goals of treatment volar Barton fractures are to restore pain-free motion, enable the patient to resume normal activities, and reduce the likelihood that early-onset arthritis, which could be debilitating, will develop. This study examines the functional and radiological results of volar Barton fractures treated with a changeable locking plate, despite the availability of a variety of therapy alternatives [15].

Of all distal radius fractures, 1.2% to 4.2% are Barton's fractures. Dorsal or volar Barton fractures are distinguished by the location and direction of the fragments [16].

Volar Barton fractures fall under category B3 fractures of the distal radius in the Acetabular Offset (AO) classification. Conservative treatment approaches sometimes lead to problems such instability, deformity, subluxation, and osteoarthritis and are ineffective. Achieving adequate reduction and stability will aid in early wrist mobilization and prevent problems in the treatment of volar Barton fractures. The following elements are necessary for fracture healing: blood flow, gap, and stability [17].

The aim of this study was to improve the outcome of surgical treatment of volar Barton fracture by plating in adults. In the current study we found that Age: The mean age of patients in the study was  $40.33 \pm 11.7$  years (range 21–59) years. Gender: 8 males (66,7%). 4 females (33,2%). Occupation: 7 heavy workers (58.33%). 3 light workers (25%). 2 housewives (16.7%). According to mode of trauma 7 patients fell on outstretched hands (58.3%). 4 patients due to road traffic accidents (33.3%). 1 patient due to fall from height (8.4%).

In agreement with our results, **Karthik et al. [18]** who reported that A mean age of  $30.43 \pm 11.3$  years was seen in 25 volar Barton fractures, with 76% of the patients being male. For 72% of the patients, the mechanism of injury was a traffic accident; for the remaining 28%, it was a fall. Regarding the age and gender predisposition for volar Barton fractures, there is conflicting literature.

**Tang et al. [19]** showed that the final analysis comprised 40 participants in total. Ten (25%) of the study population were female, and 30 (75%) were male. Nine patients (22.50%) had a history of a fall from a height, and 31 patients (77.50%) suffered RTA, among other forms of injury. Twenty-four patients (60%) had injuries to their right side, while sixteen patients (40%) had injuries to their left side.

In the present study we found that in associated medical history 3 patients had diabetes mellitus (25%). 2 patients had hypertension (16.7%). According to Dominant to non-dominant Side distribution there are 9 patients who had their dominant hand affected (75%). 3 patients had their non-dominant hand affected (25%). According to Perioperative, operative data of studied group and Time lapse before operation: we found the mean time lapse before operation of patients in the study was  $3.33 \pm 2.76$  (range 1 – 12 days). Time of operation: The mean time of operation was  $59.58 \pm 11.44$  (range 45 – 90 minute). Hospital discharge: 11 patients

discharged the next day (91.7). 1 patient discharged 2 days day (8,3%). In agreement with our results, **Ibrahim et al. [20]** who stated that the average amount of time spent before surgery was  $1.3 \pm 0.53$  (range 1-3 days), and that of the 30 patients operated upon, 16 (53.3%) were discharged the same day of the procedure and 14 (46.7%) were discharged the day following it. The mean surgical time was  $54.1 \pm 8.47$  (range 40-80 min). This contrasts with the study by **Krischak et al. [21]** where the procedure required an average of 61.3 minutes, and the timing of surgery was 4.77 days on average.

We found that the mean time of bone union in the study was  $8.33 \pm 1.37$  weeks ranged 6–10 weeks. According to Clinical and functional outcome the mean  $\pm$  SD of flexion improved from ( $29.58 \pm 8.76$ ) ranged 15–40° preoperatively to ( $66.25 \pm 7.93$ ) ranged 50–75° postoperatively, the difference statistically highly significant  $p < 0.0001$ . The mean  $\pm$  SD of extension from ( $12.5 \pm 4.78$ ) ranged 5–20° preoperatively to ( $55.83 \pm 6.71$ ) ranged 45–65° postoperatively, the difference statistically highly significant  $p < 0.0001$ . The mean  $\pm$  SD of Radial deviation improved from ( $5.83 \pm 3.99$ ) ranged 0–10 preoperatively to ( $13.75 \pm 3.8$ ) (range 7–20) postoperatively, the difference statistically highly significant  $p < 0.0001$ . The mean  $\pm$  SD of ulnar deviation from ( $7.5 \pm 4.7$ ) (range 0–15) preoperatively to ( $32.08 \pm 6.9$ ) ranged 20–40 postoperatively, the difference statistically highly significant  $p < 0.0001$ .

**Masood et al. [22]** indicated that after surgery, the mean  $\pm$ SD of flexion improved from the preoperative ( $29.5 \pm 9.59$ ) range (10-40o) to the postoperative ( $60.6 \pm 6.5$  range (50-75o). After surgery, the mean $\pm$ SD of extension increased from the preoperative range of  $12.47 \pm 5.55^\circ$  (0–20°) to the postoperative range of  $57.6 \pm 5.27^\circ$  (45–65°). After surgery, the mean $\pm$ SD of supination increased from the preoperative range of ( $22.83 \pm 6.39$ ) to the postoperative range of ( $61.6 \pm 7.11$ ) (45-75°). After surgery, the

mean $\pm$ SD of pronation increased from the preoperative range of ( $14.53 \pm 3.56$ ) to the postoperative range of ( $63.5 \pm 8.2$ ) (50–80°). After surgery, the mean $\pm$ SD of radial deviation improved from the preoperative range of  $6.57 \pm 3.04$  to the postoperative range of  $10.7 \pm 2.5$ . The ulnar deviation's mean $\pm$ SD improved after surgery, going from a preoperative range of ( $12.37 \pm 2.95$ ) to a postoperative range of ( $28.7 \pm 6.3$ ).

According to Radiological data outcome, we found The mean  $\pm$  SD of radial length increased from ( $6.8 \pm 1.4$ ) (range 5–9) preoperatively to ( $9.91 \pm 1.38$ ) (range 8–12) postoperatively, the difference statistically highly significant  $p < 0.0001$ . The mean  $\pm$  SD of radial inclination increased from ( $18.41 \pm 3.2$ ) (range 13–25) preoperatively to ( $21.66 \pm 2.32$ ) (range 18–25) postoperatively, the difference statistically highly significant  $p = 0.0001$ . The mean  $\pm$  SD of volar tilt increased from ( $8.6 \pm 1.1$ ) (range 7–11) preoperatively to ( $9.9 \pm 0.99$ ) (range 8–11) postoperatively, the difference statistically highly significant  $p < 0.0001$ . Preoperative articular step off ranged from (5-12) with median 8 decreased postoperatively to a range from (0 to 2) with median 1 with percent improvement 86.18%.

**Ali et al. [23]** noted that the volar tilt measurements were as follows: the final follow-up volar tilt was  $9.7 \pm 5.0$  degrees (range 3 to 23 degrees), the postoperative volar tilt was recorded at  $10.1 \pm 5.8$  degrees (range 0 to 25 degrees), and the preoperative volar tilt was  $-9.3 \pm 18.8$  degrees (range -40 to 28 degrees). The radial inclination measured before surgery was  $14.1 \pm 4.9$  degrees, with a range of 7 to 25 degrees; after surgery, it was  $19.3 \pm 4.2$  degrees, with a range of 12 to 28 degrees; and at the end, the radial inclination stayed at  $20.0 \pm 4.2$  degrees, with a range of 12 to 28 degrees.

In the current study we found that According to Post-operative DASH score of studied groups the mean DASH score of patients in the study was  $14.89 \pm 8.21$  (range 5–35.7).

According to Patients' satisfaction 7 patients had excellent satisfaction level (58.3%). 3 patients had a good satisfaction level (25%). 1 patient had a fair satisfaction level (8.3%) with DASH score between. 1 patient had poor satisfaction level (8.3%). According to Complications 2 patients had superficial infection (16.6%). 1 patient had malunited fracture (8.3%). 1 patient had stiffness (8.3%). These results were not compatible with **Elerian et al. [24]** who demonstrated that, for 80% of the patients in the current trial, the ultimate functional outcome as determined by the modified Mayo wrist score was good to excellent.

**Das et al. [25]** indicated that, based on the DASH score, 16 patients (53.3%) had a high satisfaction level, 23.3% had a good level, 20% had a fair level, and one patient (3.3%) had a low level.

**Alter et al. [26]** declared that the most frequent consequence in the current study was superficial wound infection, which was treated with culture-specific antibiotics and frequent dressings. Two patients had deep infections, and both required early implant removal at three months. Two patients had hypertrophic scars at the site of their surgical incisions, although these did not disturb them. For CRPS, two patients had a stellate ganglion block and physical therapy; both recovered successfully.

**Figl et al. [27]** demonstrated that a small number of individuals had wrist joint arthritis, malunion, and irritation of the extensor pollicis longus tendon along with the study's consequences, including some participants' ongoing discomfort, stiffness, and deformity.

### CONCLUSION

For improving radiological and functional outcomes, plating of the volar Barton fracture is a successful treatment. Using locking compression plates can help achieve fracture stability and early postoperative mobilization. It offers quick movement and active recuperation. Precise anatomic reduction of the fracture and restoration of the wrist's

morphology and function are made possible by quick and low-complication surgery.

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**Citation:**

Soliman, A., Mohamed Khairy, H., El-Kady, R., Abdelrahman, M. Early Results of Surgical Treatment of Volar Barton Fractures by Plating In Adults. *Zagazig University Medical Journal*, 2024; (4271-4279): -. doi: 10.21608/zumj.2024.267475.3168